

CLAIMS

1. A method for removing particles from a surface, comprising:
 - 5 applying a fluid to the surface so as to coat the particles on the surface with the fluid; and
 applying a suction force after applying the fluid so as to remove from the surface a majority of the particles that have a dimension of less than approximately one
10 micron.
2. A method according to claim 1, wherein the fluid comprises water.
3. A method according to claim 1, wherein applying the fluid comprises using a carrier gas to convey the fluid
15 to the surface.
4. A method according to claim 1, wherein applying the fluid comprises heating the fluid that is applied to the surface.
5. A method according to claim 4, wherein heating the
20 fluid comprises heating the fluid to 30-80 °C.
6. A method according to claim 1, wherein applying the suction force comprises waiting for a predetermined time period following applying the fluid before applying the suction force.
- 25 7. A method according to claim 6, wherein the time period is in the range of 0.01 to 2 seconds.
8. A method according to claim 1, wherein applying the

fluid comprises applying the fluid through a channel held approximately perpendicularly to the surface.

9. A method according to claim 8, wherein applying the suction force comprises applying the suction force
5 through an annular channel surrounding the channel through which the fluid is applied.

10. A method according to claim 9, wherein applying the suction force further comprises heating the annular channel and the fluid delivery channel.

10 11. A method according to claim 1, wherein applying the suction force comprises applying the suction force through a channel held at a tilt of 1-40 degrees from a perpendicular angle to the surface.

12. A method according to claim 1, wherein applying the
15 suction comprises applying the suction so as to generate a turbulent flow regime at the surface.

13. A method according to claim 1, and wherein applying the suction force comprises applying the suction force for a period of time between 0.1 and 10 seconds.

20 14. A method according to claim 1, wherein at least some of the particles removed have a dimension less than 0.2 micron.

15. A method according to claim 1, wherein applying the suction comprises removing the particles via a nozzle
25 having an aperture of less than 10 mm.

16. A method according to claim 15, wherein the aperture is between 0.5 and 5 mm.

17. A method according to claim 15, wherein the nozzle is placed approximately 0.1-0.5 mm above the surface.

18. A method according to claim 1, wherein the surface is the surface of a semiconductor wafer.

5 19. A method for removing particles from a surface, comprising:

applying a fluid to the surface on which the particles are distributed so as to coat the particles with the fluid; and

10 applying a suction force in a vicinity of the surface after applying the fluid so as to generate a horizontal flow velocity of the fluid of at least 100 m/s, thereby removing at least some of the particles.

15 20. A method according to claim 19, wherein the fluid comprises water.

21. A method according to claim 19, wherein applying the fluid comprises using a carrier gas to convey the fluid to the surface.

20 22. A method according to claim 19, wherein applying the fluid comprises heating the fluid that is applied to the surface.

23. A method according to claim 22, wherein heating the fluid comprises heating the fluid to 30-80 °C.

25 24. A method according to claim 19, wherein applying the suction force comprises waiting for a predetermined time period following applying the fluid before applying the suction force.

25. A method according to claim 24, wherein the time

period is in the range of 0.01 to 2 seconds.

26. A method according to claim 19, wherein applying the fluid comprises applying the fluid through a channel held approximately perpendicularly to the surface.

5 27. A method according to claim 26, wherein applying the suction force comprises applying the suction force through an annular channel surrounding the channel through which the fluid is applied.

10 28. A method according to claim 27, wherein applying the suction force further comprises heating the annular channel and the fluid delivery channel.

15 29. A method according to claim 19, wherein applying the suction force comprises applying the suction force through a channel held at a tilt of 1-40 degrees from a perpendicular angle to the surface.

30. A method according to claim 19, wherein applying the suction comprises applying the suction so as to generate a turbulent flow regime at the surface.

20 31. A method according to claim 19, and wherein applying the suction force comprises applying the suction force for a period of time between 0.1 and 10 seconds.

32. A method according to claim 19, wherein at least some of the particles removed have a dimension less than 1 micron.

25 33. A method according to claim 19, wherein applying the suction comprises removing the particles via a nozzle having an aperture of less than 10 mm.

34. A method according to claim 33, wherein the aperture is between 0.5 and 5 mm.

35. A method according to claim 33, wherein the nozzle is placed approximately 0.1-0.5 mm above the surface.

5 36. A method according to claim 19, wherein the surface is the surface of a semiconductor wafer.

37. A method for removing particles from a surface, comprising:

10 applying a fluid to the surface so as to coat the particles on the surface with the fluid; and

15 applying a suction force after applying the fluid so as to generate a horizontal flow velocity of the fluid of at least 100 m/s, thereby removing at least some of the particles that have a dimension of less than approximately one micron.

38. A method according to claim 37, wherein the fluid comprises water.

20 39. A method according to claim 37, wherein applying the fluid comprises applying the fluid through a channel held approximately perpendicularly to the surface.

40. A method according to claim 39, wherein applying the suction force comprises applying the suction force through an annular channel surrounding the channel through which the fluid is applied.

25 41. A method according to claim 40, wherein applying the suction force further comprises heating the annular channel and the fluid delivery channel.

42. A method according to claim 37, wherein the

horizontal flow velocity is in a range of a speed of sound.

43. A method of removing a particle from a surface, comprising:

5 applying a fluid to the surface so as to coat the particle;

 applying a laser beam to the surface such that absorption of the beam at the surface releases the coated particle from the surface substantially without causing
10 the particle to explode; and

 removing the released particle and the fluid from the surface by means of a suction force.

44. A method according to claim 43, wherein the fluid comprises water.

15 45. A method according to claim 43, wherein removing the released particle comprises applying a suction force in a vicinity of the surface after applying the fluid so as to generate a horizontal flow velocity of the fluid of at least 100 m/s, thereby removing the released particle and
20 the fluid from the surface.

46. Apparatus for removal of particles from a surface, comprising:

 a fluid delivery unit adapted to apply a fluid to the surface so as to coat the particles on the surface
25 with the fluid; and

 a suction unit constructed to apply a suction force to the surface after applying the fluid so as to remove from the surface a majority of the particles that have a dimension of less than approximately one micron.

47. Apparatus according to claim 46, and further comprising a vaporizer, comprising a heating element configured to heat the fluid before it is applied to the surface.

5 48. Apparatus according to claim 46, and wherein the heating element is further configured to heat the particle and fluid during their removal from the surface by the suction unit.

49. Apparatus according to claim 46, and wherein the
10 fluid delivery unit comprises a fluid delivery channel for delivering the fluid to the surface.

50. Apparatus according to claim 46, and wherein the suction unit comprises a channel for removal of the particle and fluid, constructed as an outer annular
15 channel surrounding the fluid delivery channel.

51. Apparatus for removal of particles from a surface, comprising:

a fluid delivery unit adapted to apply a fluid to the surface so as to coat the particles on the surface
20 with the fluid; and

a suction unit constructed to apply a suction force in a vicinity of the surface after applying the fluid so as to generate a horizontal flow velocity of the fluid of at least 100 m/s, thereby removing at least some of the
25 particles.

52. Apparatus according to claim 51, wherein the fluid comprises water.

53. Apparatus according to claim 51, wherein the

horizontal flow velocity of the fluid generated by the suction unit is in a range of a speed of sound.

54. Apparatus for removing a particle from a surface, comprising:

5 a fluid delivery unit adapted to apply a fluid to the surface so as to coat the particle with the fluid;

 a laser delivery unit adapted to apply a laser beam onto the surface such that absorption of the beam at the surface releases the particle substantially without
10 causing the particle to explode; and

 a suction unit constructed to apply a suction force to the surface so as to remove the particle and the fluid from the surface.

55. Apparatus according to claim 54 and wherein the
15 suction unit is further constructed to apply a suction force in a vicinity of the surface after applying the fluid so as to generate a horizontal flow velocity of the fluid of at least 100 m/s, so as to remove the released particle and the fluid from the surface.